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Proposed A Web-Based Intelligent System to Manage the Blood Bank in Zakho District

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ABSTRACT

Due to the difficulty and rarity of the data tab in blood banks, information is often lost or forgotten. Because of this, it is important to have a number of different types of blood and know the total number of blood donors, as well as the number of units of blood imported and exported daily, monthly, or yearly.
A web-based intelligent system is a web site that was created to manage the Zakho blood bank by using middleware languages like PHP that were used as transformer languages between MySQL databases as well as back-end web languages like HTML, CSS, and JavaScript that power up the front end, thus accelerating the management of blood import and export and accurately tabulating the blood donors' profiles so hospitals can get facilities that reduce the emergency cases that occur.
Machine learning, deep learning, and an algorithm based on long short-term memory (LSTM) and based on time series have been used to predict an estimation of red blood cells (RBC) for periods (weekly, monthly, and yearly) that facilitate attracting the donors and importing and exporting the amount of blood that is needed in the future, and the algorithm produced these results (MAPE 3.259, MSE is 0.001, MAE is 0.031, RMSE is 0.042, and R-Squared is 0.913)

1. Introduction

The blood Bank Management System has an essential role in the blood bank as the population grows and new technologies emerge since blood is a need for everyone. Blood transfusion and storage are crucial issues addressed internationally in many hospitals and medical institutes since blood is considered a finite resource (AlZu'bi et al., 2019) (AlZu'bi et al., 2021). This proposed Blood Bank Management System is a web-based system that would handle blood donor information and replace the blood donor red card, known as a Certificate. Because the data might be lost or redundant, it is challenging to retain the specifics of the donors and their contributions as a reference using the manual approach of storing blood donation records. If a severe blood shortage coincides, the notification should be disseminated to all donors with the appropriate blood group.

Furthermore, to increase blood donor engagement in the campaign, this system will send notification messages to all donors based on their address. In both situations, a rule-based approach is used to handle the issue, limiting specific donors' ability to plan their next blood donation by considering their blood type, eligibility to give, postcode, last donation date, and kind of blood donation permitted. The system will also calculate the total number of blood packets stored in the blood bank for each type. Finally, it is believed that this system would assist the blood bank hospital administration in making quick and efficient decisions by systematically managing blood donation operations.

Most field research relies only on the interview approach to categorize the donors. However, this study aims to leverage variables affecting prospective donors to give blood by using machine learning methods such as Artificial Neural Network (ANN) and Decision Tree to categorize the surveyed data using trusted external judgments (Boonyanusith & Jittamai, 2012). The main problem in the blood donation process is insufficient to collect and manage the blood donation process (Mousa et al., 2020).

Generally, there is no plan for managing the blood donation and analyzing the blood bank data in terms of the required amount of blood that will need it in Zakho (as a case study), the type of blood, and the classification of the donors. In this paper, some related work has been reviewed and a web-based system based on the web developed for Zakho district as a case study to optimize the process of blood donation. Also, it is to predict the need for blood (RBC) in the future using machine learning and deep learning, and the LSTM algorithm is unsupervised based on time series.

2. Literature review

The literature review section discusses the previous research papers. The data gathered focuses on what approach was used and what contributions the study made to enhancing the utilization of the blood bank management system.

In (Hashim et al., 2014), A web-based system was developed to educate the community about the benefits of blood donation. Create a web-based blood bank system to handle donor and receiver records, encourage voluntary blood donation, and access information on blood type and blood distribution in various hospitals in Jeddah depending on hospital needs.

The Waterfall Methodology is employed to create and construct the web-based blood bank. The system was built utilizing HTML, PHP, and MySQL database systems to handle and store the data. The system is designed for three sorts of users: the general public who want to give blood. Receivers who need to be donated blood and hospitals act as an intermediary to facilitate communication between donors and recipients.

Data mining is a method for uncovering new patterns in massive databases. It may extract information from current data sets and turn it into a human-readable framework for future usage. It employs approaches from statistics, database systems, machine learning, and artificial intelligence (Smith & Gupta, 2000).

The blood has been categorized in the study [3], which is done via an online questionnaire based on the variables affecting blood donation choices. These elements, including altruistic ideals, knowledge of blood donation, perceived risks, attitudes toward blood donation, and desire to give blood, are examined to determine the likelihood of persons becoming blood donors. The collected data is utilized in machine learning methods of Artificial Intelligence to categorize blood donors as donors or non-donors. The accuracy of the surveyed information was a test using Artificial Neural Network (ANN) and Decision Tree approaches to forecasting whether or not each person is a donor based on a set of individual blood behavior data. The findings show that the ANN approach has superior accuracy, precision, and recall values to the Decision Tree technique.

Due to the significant effect of blood shortages on patient survival, much research has been undertaken into the variables that affect the behavior of blood donors. In (Mostafa, 2009), five characteristics led to the investigation of blood donor behavior. These are the following factors: altruistic values, perceived risks of blood donation, blood-donation knowledge, attitudes toward blood donation, and desire to give blood.

Research on the elements that promote the altruistic value of blood donation was conducted in Thailand (Wiwanitkit, 2000). People with pleasant attitudes are often attentive to others and selfless (Piliavin & Callero, 1991). One of the significant factors influencing blood donation decision-making is donors' perceptions of the hazards involved [6]. It impacts donors' unfavorable attitudes regarding blood donation (Tscheulin & Lindenmeier, 2005).

Furthermore, donors' willingness to give blood is directly affected by their fear of infection (Robertson & McQueen, 1994), assuming that people who share blood are more likely to be infected than those who do not. Other, those who have previously given blood tend to have good attitudes toward blood donation (Hosain et al., 1997) and may donate more in the future since they are more familiar with blood donor screening procedures than first-time donors (Zaller et al., 2005).

Blood donors often have a far more favorable attitude and intention toward blood donation than people who have never given blood. One of the most important criteria that may be utilized to predict blood donation behaviors is the desire to give blood. These five elements are used in the development questionnaires to solicit people's thoughts. In Thailand, this information is utilized for blood donor categorization analysis.

In Anandhi et al. (2021), researchers utilized machine learning to propose donations using a smartphone app. The blood-donation center's objective is to collect blood from diverse donors, verify the blood collection database, and send the proper blood to a medical institution in the case of a medical emergency. The issue isn't a lack of contributions; it's finding a willing sponsor at the proper time. They need to create a network of individuals who can help one another in a disaster.

This application is lucky because it updates donors' data, and the administrator has access to all information regarding running the blood donation station. Donors will be encouraged to provide personal information such as their name, phone number, and blood type. The framework uses GPS notifications on the contributor's mobile device to track the locations of outstanding donors. Only donors within a certain radius of the need are contacted. This android-powered Blood Bank Project tries to halt the course of life by making the best decisions for the promoter on behalf of a penniless inheritor. As a consequence, the majority of events will inspire individuals to live longer lives.

In Salazar-Concha & Ramrez-Correa (2021), the researchers use a decision tree to analyze the control factors and rely on some data to forecast the donors' desire to contribute again. where data science approaches are routinely employed to assist health authorities in forecasting and tracking. Furthermore, the researchers indicated that COVID-19 makes blood donation considerably more complex since donors' behavior changes after COVID-19, and the number of donors less after the pandemic of COVID-19.

In that study, the scientists employed a decision tree to predict the donors' intention to give blood. Using a decision tree method to assess the obtained data, that study concludes that the potential of repeating the blood donation depends on seven factors with an accuracy of 84.17 percent.

Shah et al. (2022) implements database management to govern blood storage. The researchers created a database using a Microsoft SQL Server to centralize and save time while storing the volumes of blood. One of the most critical aspects of the study is to remind donors to donate their blood and deliver it to a local donation site to simplify the donation procedure. IoT connects the application's database to the server to take more efficient data.

In Krishna & Nagaraju (2016), the receptor sends a text message via SMS to a shared blood bank platform containing a list of blood groups available at a particular blood bank; the receptor directly to that bank; otherwise, the receptor delivers contact information for donors who have the requisite blood group.

In Esmail & Osman (2018), a computer-based blood management system was developed to manage, monitor, and store blood information while also improving medical treatment by creating a secure medical report. The MySQL database, bar-code technology, and the PHP programming language were used to build the system.

It was tested in collaboration with the National Blood Transfusion Center (NBTC), which aided in improving system manipulation over manual systems.

Ali et al. (2017) presents a web-based application to handle the issue of restricted blood supplies caused by various issues like uncontrolled blood management, shortages of specific blood types, and a lack of understanding about blood donation. The proposed application governs blood bags' administration, testing, storage, and transportation.

Academics in Egypt created a mobile-based method for improving blood bank administration (Mousa et al., 2020). The suggested strategy is divided into three major categories: First, there is the hospital sub-system, which organizes the blood bags and records requests. In addition, keep an eye on the available blood bags. Second, there is the blood bank and campaign sub-system, which organizes blood delivery and monitors campaigns. The thirst section is a sub-system of the donors. It aims to expand the number of contributors as well as their collaboration. HTML, CSS, JavaScript, and data analysis are the technologies employed in the suggested system. This makes the waiting time longer, especially in cases of organ donation, which most often involve the heart, liver, and kidney. In these cases, the organs may sit unused because of bad management or because they are no longer helpful (Khram, I. et al., 2021). Because Excel is utilized in medical facilities as a database, there is no list of blood donors that can be used in an emergency.

As a consequence, it lacks credibility. Due to a lack of technology for donation communication, there needs to be more public awareness about blood donation (Shashikala, B. et al., 2018), (Ahmed, A. et al., 2018). Additionally, inadequate management causes a breakdown in communication between medical facilities and donors, which results in misplaced blood bags and a shortage of certain blood kinds (Das, H.D. et al., 2020).Comparatively to Shah et al. (2022), the authors used a blood bank management system to remind donors to donate blood, as well as to request and demand blood. The proposed system will manage the blood bank in Zakho District, which did not have a management system. It is essential to note that the system is intelligent by applying an intelligent algorithm to predict the amount and types of blood in Zakho District (weekly, monthly, and annually).

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3. MATERIAL AND METHODS

3.1 Material

Because there is no dataset available for blood banking, a synthetic dataset was created in which data values were collected based on the Zakho blood bank on papers was wrote from (01/01/2015) to (22/07/2022). The number of recording data it was 2760. However, this dataset aims to predict values of each blood types for future needed next week, next month, and next year. The dataset includes 9 features and 48,719 units of RBCs samples representing of blood types used.

Table 1 presents an example of the simulated dataset with date and eight numerical attributes: Record Date, A+, A-, B+, B-, AB+, AB-, O+, and O-.

Table 1: A sample of the dataset

Record Date	A+	A-	B+	B-	AB+	AB-	O+	O-
01/01/2015	1	0	0	1	0	0	0	0
02/01/2015	12	3	4	1	1	0	4	3
03/01/2015	3	0	4	0	2	0	4	0
04/01/2015	10	0	3	1	2	0	7	0
05/01/2015	7	2	9	0	1	0	1	0
06/01/2015	7	1	4	2	0	1	5	2
07/01/2015	2	0	0	0	0	0	2	0

Programming languages and tools based on the web used different tools in order to design the system. HTML (Hyper Text Markup Language), CSS (Cascading Style Sheets), JavaScript, and Bootstrap as frond-end. MySQL used for database as a back-end and PHP (Hypertext Preprocessor) with Laravel framework as a Middle-ware. Also used Python to machine learning and deep learning-based LSTM algorithm.

Red blood cells (RBCs), a component that can save a patient's life, are used to treat emergency patients (D. Pi et al., 2018), and they are also the blood Types that is most in demand (Table 1).

According to Table 1, 6436 units of RBCs were requested from the blood bank of Zakho district from July 22, 2021, to July 22, 2022.

Table1.

Blood Types	A+	A-	B+	B-	AB+	AB-	O+	O-	Total RBCs
Amount(units)	2020	274	1161	171	400	46	1985	379	6436
Percentage (%)	31%	4%	18%	3%	6%	1%	31%	6%	100%

3.2 Methods

web-based system based on the web developed for Zakho district as a case study to optimize the process of blood donation. Also, it is to predict the need for blood types (RBC) in the future using machine learning and deep learning, and the LSTM algorithm is unsupervised based on time series.

The main modules of the proposed system will be appointed in this section, which will be presented as follow: In figure (1), the process of blood donation as shown; the first step is the blood will go through some tests to check whether the blood is suitable to be given to the patient. Blood tube will be given a unique number then will be checked in the blood group and viruses test.

The data of this process will be saved and filtered to create a new dataset for the blood bank in Zakho District as it is not available. All the data will be analyzed to find the accurate amount of the required blood in Zakho District, the type of the blood, and the classification of the donors. Another criterion for good blood donation management systems is their cap district to identify enough blood storage and define future blood supply by precisely estimating the number of donors. Furthermore, these systems should strive to eliminate blood product waste due to expiry and the need to import new blood units from outside sources.

As shown in figure (1) the proposed system is used machine learning and deep learning based on long short-terms memory (LSTM) algorithm as an artificial neural network.

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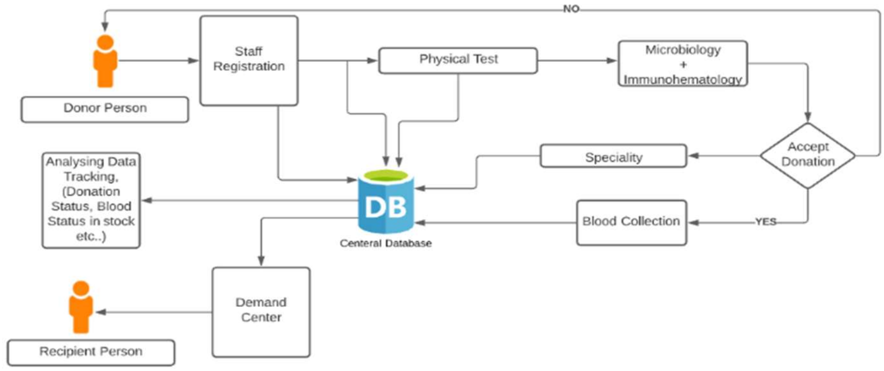

Figure 1: Donation process

The proposed system that based on the web used different tools in order to design the system. HTML, CSS, JavaScript, and Bootstrap as a frond-end. MySQL used for database as a back-end and PHP with Laravel framework as a Middle-ware. Figure (2) shows the main block diagram of the proposed system

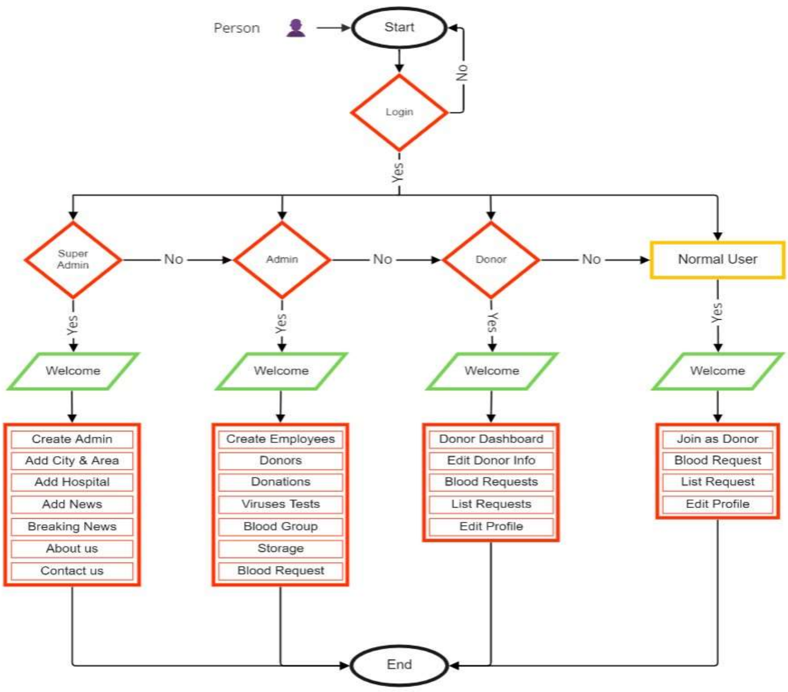

Figure 2: Proposed system

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The Super Admin, Admin, Donor, and requesting blood. the home page of the website and continent that pages shows in figure (3).

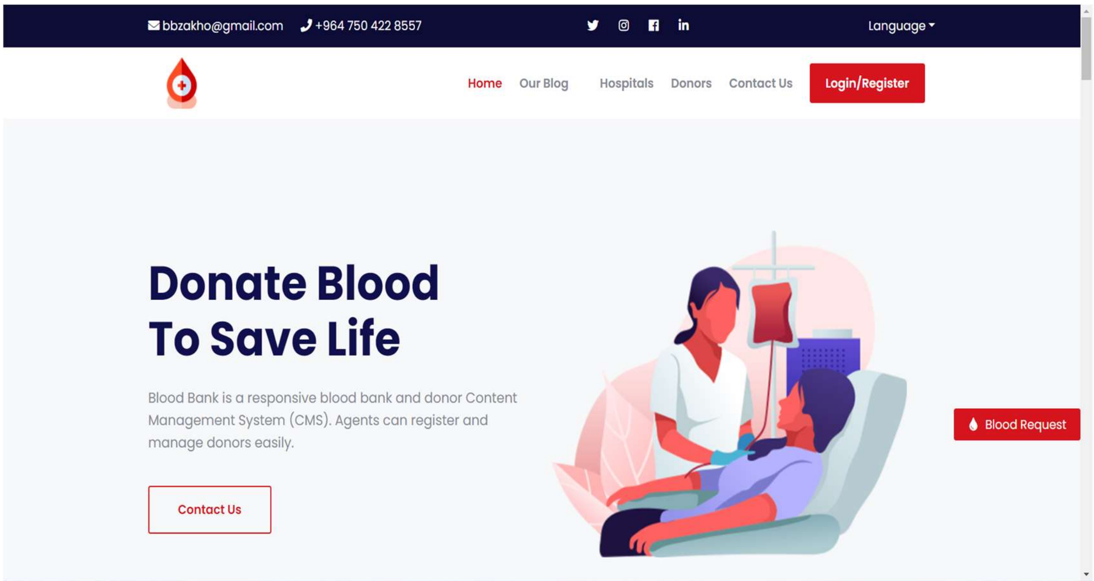

Figure 3: Home Page

The main feature of the super admin is creating a user(s) for each hospital as a sub-user in the system. where the main actions of the super admin are: Delete, Edit, and Add shows in the super admin's Dashboard Figure (4).

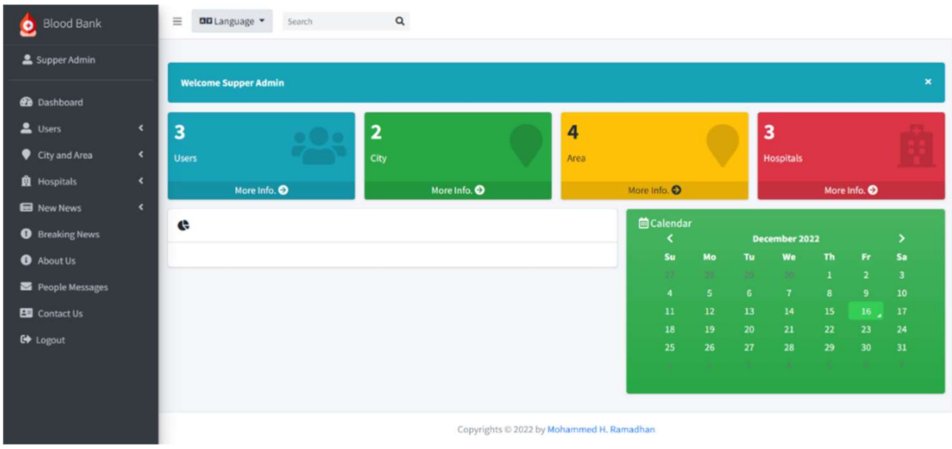

Figure 4: Super Admin Dashboard

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In the Figure (5) dashboard of the main admin where the admin can add donors, donor list, register donors, and statistical data about the donation process. All the donors' information is available, and the admin can do the actions (view, add donors, show all donors, print, edit and delete).

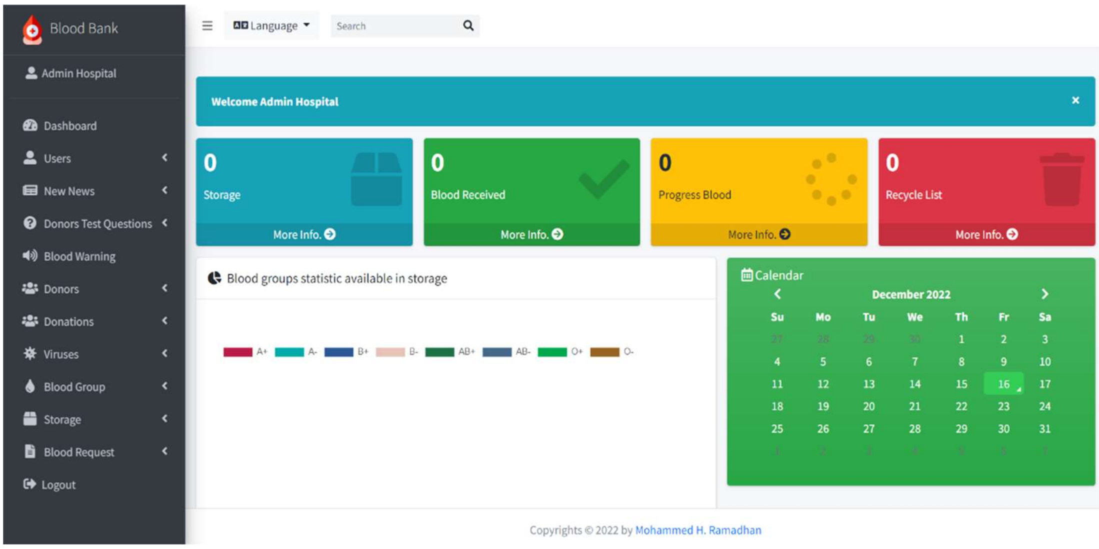

Figure 5: Admin Dashboard

The number of recording data it was 2759. 70% of data used for train the model and 30% used to test the model. The model decreased in every epoch until 300 epochs as showing in finger (6).

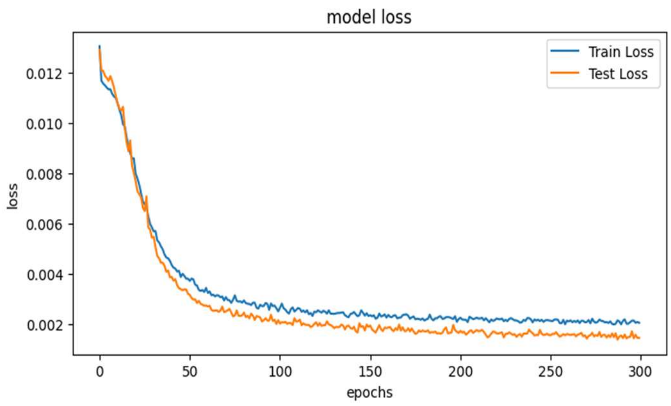

Figure 6: LSTM Model Loss

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3.3 Deep learning method

The deep learning (DL) method is an AI method that uses a multi-layered (deep) architecture to match the relationships between inputs or observed features and the result. It has been used in many fields of science, business, and administration, as it is very good at discovering complex structures in high-dimensional data (Y. LeCun et al., 2015). There is some advantage to using the DL method according to machine learning. It can calculate in one layer instead of many layers to discover even the parameters you need to define in machine learning and to determine better parameters. The disadvantage of DL is the risk of over-compliance problems (S.B. Golas et al., 2018).

4. Intelligent Blood bank system

Blood donation ensures enough blood supply to fulfil medical demands while also saving the lives of others. Blood banks are essential in collecting whole blood from voluntary blood donors. To prevent infection, donors' whole blood is checked and analyzed before use. Most blood banks and hospitals keep blood products in inventory, where they must be maintained in certain ideal conditions and kept frozen or refrigerated (Shih & Rajendran, 2019) (Al-Zu'bi et al., 2017). Furthermore, where the shelf-life is limited from donation to usage, they must be disposed of after reaching their maximum shelf-life (Pierskalla, 2005). Plasma, for example, may be retained for one year, RBCs for 42 days, and platelets for just five days (Shih & Rajendran, 2019). As a result, there should be consistency, and the blood products should be permanently supplied in inventories to maintain them stocked. The procedure of collecting, testing, and processing whole blood, on the other hand, is expensive. Furthermore, blood products beyond their maximum shelf-life are destroyed and become garbage, which is costly since these blood products have already been paid for. As a result, erroneous estimates of blood demand may result in various issues, including increased charges, poor service quality, blood shortages, overproduction, and overstocking. These challenges demonstrate that collecting, providing, transfusing, and storing blood is intricate and complex, particularly when aligning hospital demand for blood products with blood availability. Furthermore, we must consider that there are several blood kinds, and not all of them may be utilized for transfusion, depending on finding a suitable blood type for the patient (Hawashin et al., 2019) (Lowalekar & Ravichandran, 2015).

5. Conclusion

Due to the difficulty and rarity of the data tab in blood banks, information is often lost or forgotten. Because of this, it is important to have a number of different types of blood and know the total number of blood donors, as well as the number of units of blood imported and exported daily, monthly, or yearly.

Methodologies and techniques are presented. Some regulations govern blood donor classification and blood expiration. The study also discussed how blood donations are regulated and how to fix them. Manage the blood bank and transfusion process. Machine learning will estimate next week's, next month, or next year's blood needs. The front-end employs HTML, CSS, and JavaScript, and the middleware uses PHP in MySQL. The suggested system will predict future blood (RBC) needs utilizing machine learning, deep learning, and the LSTM algorithm based on time series, where the MAPE 3.259, MSE of 0.001, MAE of 0.031, RMSE of 0.042, and R-Squared of 0.913.

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پێشنیاری سیستەمێکی زیرەکی وێب بۆ بەڕێوەبردنی بانکی خوێن لە شاری زاخۆ

پوختە:

بەهۆی سەختی و دەگمەنی تابی داتا لە بانکەکانی خوێندا، زۆرجار زانیارییەکان لەدەست دەچن یان لەبیر دەکرێن. بەهۆی ئەمەوە گرنگە کۆمەڵێک جۆری جیاوازی خوێن هەبێت و کۆی ژمارەی خوێنبەخشەکان بزانیت، هەروەها ژمارەی یەکەکانی خوێنی هاوردە و هەناردەکراو ڕۆژانە، مانگانە، یان ساڵانە.

سیستەمی زیرەک لەسەر بنەمای وێب وێب سایتێکە کە بۆ بەڕێوەبردنی بانکی خوێنی زاخۆ دروستکراوە بە بەکارهێنانی زمانی میدلوێری وەک PHP کە وەک زمانی گۆڕینی لە نێوان بنکەدراوەی MySQL و هەروەها زمانە وێبەکانی پشتەوەی، HTML و CSS و JavaScript کە بەکاردەهێنرا بەهێزکردنی کۆتایی پێشەوە، بەم شێوەیە بەڕێوەبردنی هاوردەکردن و هەناردەکردنی خوێن خێراتر دەبێت و بە وردی خشتەی پرۆفایلی خوێنبەخشەکان بۆ ئەوەی نەخۆشخانەکان بتوانن ئاسانکارییەک بەدەستبهێنن کە حاڵەتە فریاگوزاریەکان کەمبکەنەوە کە ڕوودەدەن.

فێربوونی ئامێر، فێربوونی قووڵ و ئەلگۆریتمێک لەسەر بنەمای بیرەوەری کورتخایەنی درێژخایەن (LSTM) و لەسەر بنەمای زنجیرە کاتییەکان بەکارهێنراون بۆ پێشبینیکردنی خەمڵاندنی خڕۆکە سوورەکانی خوێن (RBC) بۆ ماوەی (هەفتانە، مانگانە و ساڵانە) کە ئاسانکاری دەکەن ڕاکێشانی بەخشەرەکان و هاوردەکردن و هەناردەکردنی ئەو بڕە خوێنەی کە لە داهاتوودا پێویستە، و ئەلگۆریتمەکە ئەم ئەنجامانەی بەرهەمهێنا (MAPE 3.259، MSE 0.001، MAE 0.031، RMSE 0.042، و R-Squared 0.913)

اقتراح نظام ذكي قائم على الويب لإدارة بنك الدم في مدينة زاخو

الملخص:

نظرًا لصعوبة وندرة علامة تبويب البيانات في بنوك الدم ، غالبًا ما تُفقد المعلومات أو تُنسى. ولهذا من المهم أن يكون لديك عدد من أنواع الدم المختلفة ومعرفة العدد الإجمالي للمتبرعين بالدم وكذلك عدد وحدات الدم التي يتم استيرادها وتصديرها يوميًا أو شهريًا أو سنويًا.

النظام الذكي المستند إلى الويب هو موقع ويب تم إنشاؤه لإدارة بنك الدم في زاخو باستخدام لغات وسيطة مثل PHP التي تم استخدامها كلغات تحويل بين قواعد بيانات MySQL بالإضافة إلى لغات الويب الخلفية مثل HTML و CSS و JavaScript التي تدعم الواجهة الأمامية ، وبالتالي تسريع إدارة استيراد وتصدير الدم

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وجدولة ملفات المتبرعين بالدم بدقة حتى تتمكن المستشفيات من الحصول على مرافق تقلل من حالات الطوارئ التي تحدث.

تم استخدام التعلم الآلي والتعلم العميق والخوارزمية القائمة على الذاكرة طويلة المدى (LSTM) واستنادًا إلى السلاسل الزمنية للتنبؤ بتقدير خلايا الدم الحمراء (RBC) لفترات (أسبوعية وشهرية وسنوية) تسهل جذب المتبرعين واستيراد وتصدير كمية الدم المطلوبة في المستقبل ، وأنتجت الخوارزمية هذه النتائج (MAPE 3.259، MSE 0.001، MAE 0.031، RMSE 0.042، R-Squared 0.913)